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MISSISSAGI RIVER
BANK STABILIZATION PROGRAM
AQUATIC MONITORING
1983

Report No. 84-144-K

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ABSTRACT

The effects of river bank stabilization work on the Mississagi River water quality and fish habitat were monitored in July, August and October . Analysis of water quality samples indicated no measureable change in the river system water quality from construction activities as parameters were similar before and after construction and above and below construction. Increased turbidity and filtrable residue levels were limited to within 300 m downstream from construction activity. Spawning habitat downstream of construction activity was not adversely affected by deposition of suspended materials from the construction site. Yellow perch was the predominant fish species and the only species located at all sampling locations. In most instances young of the year yellow perch were more abundant than adult yellow perch. The highest fish abundance was recorded at construction site F. It is not known whether the high abundance at this construction site was attributable to the newly created fish habitat.

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To Dr. W.R. Effer
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MISSISSAGI RIVER
BANK STABILIZATION PROGRAM
AQUATIC MONITORING
1983

1.0 INTRODUCTION

The river banks along the lower reaches of the Mississagi River in the vicinity of Iron Bridge have been subject to severe erosion. This erosion was attributable to natural processes (land runoff and flood flows) and to the peaking operations of the Mississagi River hydro electric generating stations. To reduce further erosion created by daily water level fluctuations, Ontario Hydro commenced a river bank stabilization program between Red Rock Falls GS and Mississagi Chutes in 1983. The stabilization of the river banks will permit Ontario Hydro to continue its peaking operations without damaging private lands. The stabilization work is to be conducted in three phases (bank clearing, rock placement and final bank shaping) commencing with truck and crane operations in 1983 and continuing for a period of 3 to 5 years using barges at deep water sites.

Environmental Studies and Assessments (ES&A) requested Biological Research Section to monitor the effects of the bank stabilization program on the Mississagi River water quality and fish habitat. The program involved sample collection by personnel from ES&A and Biological Research. Sampling was scheduled to coincide with each phase of construction activity (Table 1.0-1).

2.0 Methods

2.1 Water Quality

Water samples were collected above and below active construction sites and along the extent of the visible turbidity plume resulting from construction activities during the summer and fall to provide information on the extent and duration of construction effects on the Mississagi River water quality (Figure 2.1-1).

Table 1.0-1

Sampling and Construction Schedule
Mississagi River Project, 1983

Sampling Date	Construction Activity Monitored
July 20	bank clearing and rock placement
August 23 - 25	rock shaping and bank clearing
October 26	trucking of rock and rock placement flow test

The sampling locations and dates are outlined in Table 2.1-1. The water samples were collected by immersing 1 litre (L) borasilicate glass collection bottles 30 cm below the river surface.

Paired water samples were collected at the Red Rock GS tailrace and the Mississagi Chutes flow gauge to provide water quality information during a variety of operating and water level conditions (Figure 2.1-1). Two paired samples were collected on July 20, on August 25/26, and on October 26. The October 26 water samples were collected at normal and peak (255 m^3/s, 9000 cfs) station operating conditions.

All water samples were refrigerated and submitted to Analytical Services, Chemical Research Department, for analyses of conductivity, non-filtrable residue at 105 and 550 °C, filtrable residue at 105 and 550 °C and turbidity.

2.2 Spawning Habitat

The gravel bar 50 m downstream of the centre span of the Highway 17 bridge in the town of Iron Bridge was sampled for particle size distribution on July 20 and August 25 (Figure 2.2-1). Triplicate samples were collected with a ponar grab and with a pipe sampler (5 inch ID pipe with a scoop welded to 1/3 of the opening) on July 20 and with the pipe sampler alone on August 25. The ponar grab was placed on the gravel bed and then forced into the substrate by standing on it. The pipe sampler was pushed into the substrate at a 45 ° angle in an upstream direction. All substrate samples were transferred to plastic bags upon the removal of the samplers from the substrate to minimize the loss of fines. Each sample was sieved through a series of 8 sieves (31.5 - 0.038 mm) using the wet sieving method. The samples were then oven dried to a constant weight. The per cent by weight in each particle size range was calculated.

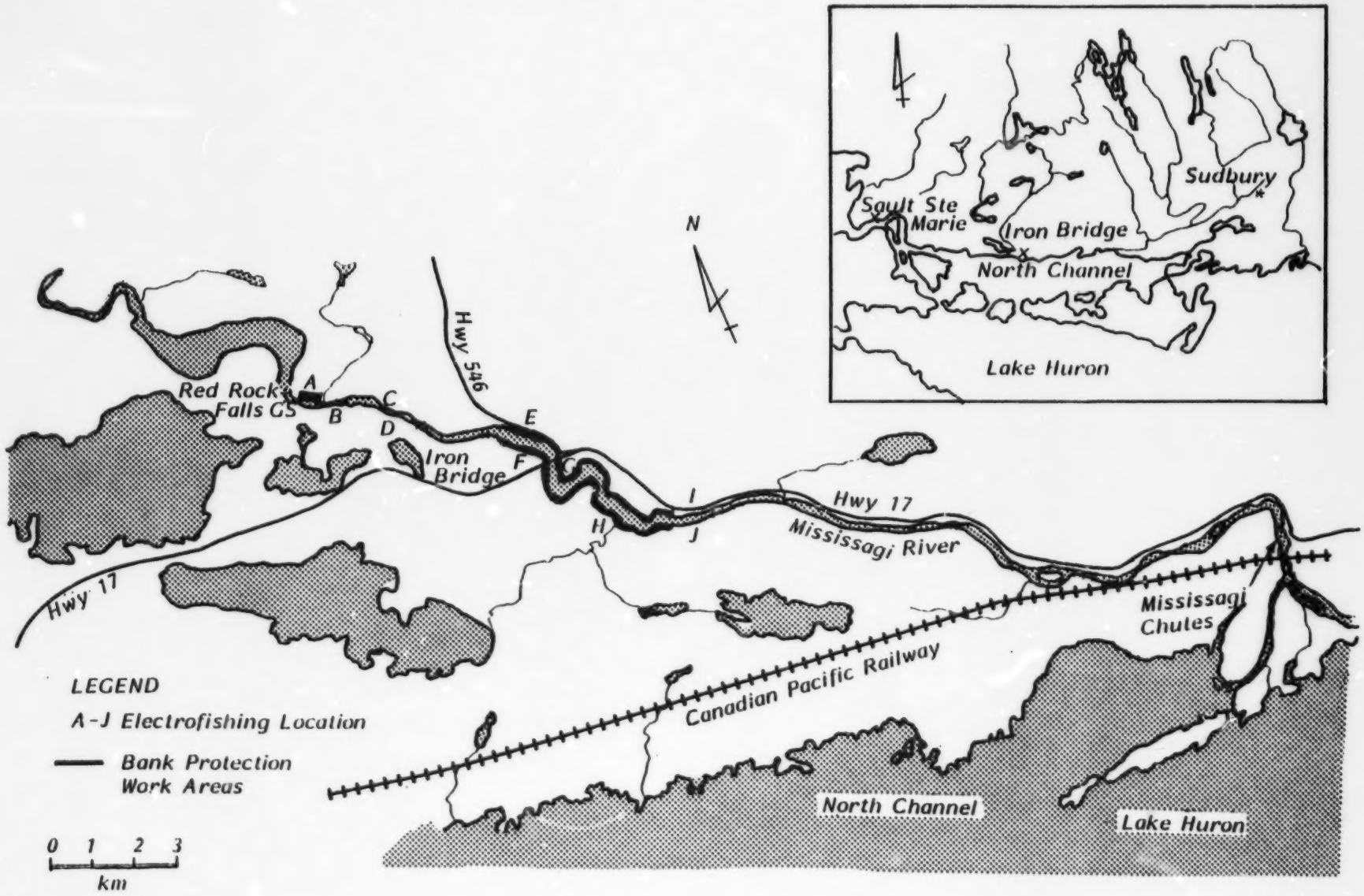

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FIGURE 2.1-1

SAMPLING LOCATIONS - MISSISSAGI RIVER STUDY, 1983

2.3 Fish Monitoring

Fish populations were sampled with the use of electrofishing equipment at 10 shoreline sampling locations (Figure 2.1-1). The electrofishing equipment consisted of a Smith Root Mark VI electroshocker mounted on a 7m boat. The electroshocker was operated on a pulsed direct current (DC) mode at 60 pulses per second and with a pulse width of 4 milliseconds (ms). The voltage used ranged between 629 and 1008 VDC while the amperage ranged from 2 - 4 amps.

TABLE 2.1-1

Water Sampling Locations
Mississagi River Project, 1983

SAMPLING LOCATION	SAMPLING DATE		
	July 20	August 25/26	October 26
Red Rock GS tailrace	x	x	x***
F 1 (upstream end Site F)		x**	
F 2 (50 m downstream of Site F 1)		x	
F 3 (100 m downstream of Site F 1)	x*	x	
F 4 (200 m downstream of Site F 1)		x	
F 5 (300 m downstream of Site F 1)	x	x	
mid stream Site H		x**	
mid stream Site I		x**	
Mississagi Chutes	x	x	x

* - July water samples were collected along west bank construction (rock dumping and placement) at site F
** - August water samples were collected along east bank construction (final grading with Gradall) at site F and bank clearing between sites H and I
***- collected to measure the effects of peak flows over newly placed rock

The 10 shoreline sampling sites were each sampled in a downstream sequence commencing at site A (Red Rock GS tailrace) for 20 minutes during the day on August 23. The decision was then made to switch to a night sampling program in an attempt to increase the number of fish collected and to avoid fluctuations in flow rates as Red Rock GS ceased operation late in the evening. Night sampling was conducted in a downstream sequence at the sites as outlined in Table 2.3-1 using 100 m of shoreline as the size of the sampling unit. Lights were installed on the boat to aid in electrofishing and navigation. All fish collected were speciated and enumerated. An estimate was made of the numbers of each species of fish which were not retrieved at each sampling location. Any fish that could not be identified in the field was preserved and identified in the laboratory.

Electroshocker and boat steering assembly malfunctions prevented the sampling of the fish populations at all sites south of Red Rock GS (site A) on August 23 and 25 respectively.

3.0 Results

3.1 Water Quality

The water quality analysis results are presented in Appendix A. The July and August samples were collected to monitor the effect of construction activity on water quality while the October samples were collected before and during a peak flow test (Table 2.1-1).

3.1-1 Specific Conductance

Specific conductance is a measure of the total amount of ionized materials in the water. The specific conductance values measured at the Mississagi River were low , typical of Precambrian Shield areas (OHRD Report C81-127-K). The variation amongst samples was small during construction activity with specific conductance values ranging from 5.6 mS/m (Red Rock GS tailrace, July) to 6.5 mS/m (Site F-1 start, August). The mean August specific conductance value was 6.1 mS/m.

The specific conductance (October) was 6.1 mS/m at the Red Rock tailrace during normal and peak operating conditions and at the Mississagi Chutes during peak conditions. The specific conductance at the Mississagi Chutes was slightly higher during normal flow conditions (6.6 mS/m).

3.1-2 Non-filtrable Residue at 105 °C

Non-filtrable residue at 105 °C is a measure of the quantity of material that remains as a residue after the water is removed from a filtered portion of a sample by evaporation. The July control non-filtrable residues at 105 °C ranged from 50 mg/L at the Red Rock GS tailrace to 58 mg/L at the Mississagi Chutes. The non-filtrable residues at 105 °C at construction site F ranged from 50 to 52 mg/L comparable to the upstream control

TABLE 2.3-1

August Fish Sampling Locations
Mississagi River Project, 1983

SITE	SITE DESCRIPTION	DAY	NIGHT		
		DATE			
		23	23/24	24/25	25
A*	upstream control - rock	X	X	X	X
B	upstream control - boulder	X		X	
C	upstream control - sand & debris, East bank	X		X	
D	upstream control - sand & debris, West bank	X		X	
E	treated, East bank	X		X	
F	treated, West bank	X		X	
G	to be treated - sand, East bank	X		X	
H	to be treated - sand and vegetation (cleared)	X		X	
I	downstream control - sand & debris, East bank	X		X	
J	downstream control - sand & vegetation, West Bank	X		X	

* - sampling conducted in sequence from sites A to J

value. The August non-filtrable residue values at 105 ° C ranged from 48 (site F-5) to 74 mg/L (Sites I&J). The mean construction site non-filtrable residue value at 105 °C was 57.6 mg/L. This value was lower than the measured 66 mg/L at the upstream control site (Red Rock GS tailrace) as was the non-filtrable residue at 105 °C value measured at the Mississagi Chutes (60 mg/L).

The October non-filtrable residue values at 105 °C ranged from 52 mg/L during the peak flow conditions at both sites to 60 mg/L at the Mississagi Chutes during normal flow conditions. This range in non-filtrable residue values at 105 °C is similar to the Red Rock tailrace values during July (50 mg/L) and August (66 mg/L) sampling periods.

Provincial water quality objectives state that non-filtrable residue values must not be increased by more than 1/3 of the natural concentrations, to protect aquatic life (Ontario Ministry of Environment [OMOE], 1978). The total non-filtrable residue levels recorded during the sampling periods did not exceed the OMOE water quality objectives.

3.1-3 Non-filtrable Residue at 550 °C

Non-filtrable residue at 550 °C is a measure of the quantity of material (inorganic and non volatile) that remains as a residue when the non-filtrable residue at 105 °C is ignited at 550 °C for 1 hour. The July non-filtrable residue values at 550 °C ranged from a high of 24 mg/L at the Red Rock GS tailrace above construction to 12 mg/L below construction at the Mississagi Chutes. The organic/volatile fraction varied slightly between the upstream control (26 mg/L) and construction sampling sites F-3 and F-5 (34 mg/L). Values increased to 46 mg/L downstream at the Mississagi Chutes. The August non-filtrable residue values at 550 °C were lowest at site F-5 (6 mg/L, grading activity) but were highest at sites F-1 and F-4 (30 mg/L). The mean construction site non-filtrable residue value at 550 °C was 20 mg/L. The August control site non-filtrable residue values at 550 °C were 10 and 14 mg/L at the Mississagi Chutes and Red Rock GS tailrace respectively. The organic/volatile fraction was highest at site I (58 mg/L). However, this value was only slightly greater than the Red Rock tailrace control value (52 mg/L).

The non-filtrable residue value at 550 °C was highest at the Red Rock tailrace during normal October flow conditions (41 mg/L). The lowest value (28 mg/L) was recorded at the Mississagi Chutes during peak flow conditions. The organic and volatile non-filtrable residues were lower at the Red Rock tailrace during normal flow (13 mg/L) than during peak flow (19 mg/L) conditions. The organic and volatile non-filtrable residues were slightly higher at the Mississagi Chutes during normal flow (28 mg/L) than during peak flow (24 mg/L) conditions.

3.1-4 Turbidity

Turbidity is a measure of the optical properties of a sample which causes light to be scattered rather than transmitted in a straight line. The July construction site F-1 turbidity value (0.66 Nephelometric Units [NTU]) was greater than the upstream Red Rock GS tailrace control value (0.23 NTU). However, the turbidity values determined downstream of site F-1 decreased to 0.27 and 0.28 NTU at site F-3 and the Mississagi Chutes. The August turbidity values were also highest at site F-1 (30 NTU, grading activity). Downstream of site F-1 turbidity values decreased from 3.6 NTU at site F-2 to 0.51 NTU at site F-5. August control values ranged from 0.42 NTU at the Red Rock GS tailrace to 0.68 NTU at the Mississagi Chutes.

October turbidity values increased from 0.62 NTU at the Red Rock tailrace to 1.4 NTU at the Mississagi Chutes during normal flow conditions and from 1.2 to 1.6 NTU at the same locations during peak flow conditions.

3.1-5 Filtrable Residue at 105 ºC

Filtrable residue at 105 ºC indicates the quantity of material that may be removed from a water sample by filtration. The July filtrable residue values at 105 ºC ranged from 1.0 mg/L at the Mississagi Chutes to 5.5 mg/L at site F-3. A value of 3.3 mg/L was recorded at the upstream control (Red Rock GS tailrace). August filtrable residue values at 105 ºC were generally less than the detection limit (1 mg/L). The only filtrable residue value at 105 ºC greater than the detection limit was recorded at site F-1 (4 mg/L).

A filtrable residue value at 105 ºC of 2 mg/L was recorded at both sampling sites during normal October flow conditions. The filtrable residue values at 105 ºC decreased slightly to 1 mg/L at both sampling sites during peak flow conditions.

3.1-6 Filtrable Residue at 550 ºC

Filtrable residue at 550 ºC is a measure of the quantity of material (inorganic and non volatile) that remains as a residue when the filtrable residue at 105 ºC is ignited at 550 ºC for 1 hour. The filtrable residue values at 550 ºC recorded at site F-3 in July and site F-1 in August were 1 and 2 mg/L respectively. Filtrable residue values at 550 ºC recorded at all other sites on all dates were less than the detection limit (1 mg/L).

3.1-7 Secchi Disc Measurements

A Secchi disc reading of 3.0 m was recorded above the bank stabilization sites on July 20. One hundred metres downstream of rock placement work at site F-3, a Secchi disc value of 0.3 m was recorded. Further downstream at the Highway 17 bridge the Secchi disc reading had increased to 3.0 m. A Secchi disc reading of 2.8 m was recorded below active construction at the Highway 17

bridge on August 25. Secchi disc readings of 3.3 and 2.3 m were recorded above (site H) and below bank clearing operations (site I) respectively. To meet OMOE water quality objectives the natural Secchi disc values should not decrease by more than 10% when materials are added to the surface water. In July the Secchi disc reading increased more than 10% in the immediate vicinity of construction. However, there was no difference 0.5 km downstream of construction.

3.2 Spawning Habitat

The results of particle size analysis of the Iron Bridge spawning bed substrate are presented as percent of substrate (dry weight) in Appendix B. A comparison of the mean particle size samples collected in the ponar grab samples and the pipe sampler is presented in Table 3.2-1. The results of one way analysis of variance indicated the pipe sampler was significantly ($P > .05$) more efficient than the ponar grab in collecting substrate fines. Analysis of the pipe sampler samples indicated the pebble-gravel component (2-31.5 mm) was the predominant substrate type during both sampling periods comprising mean values of 52 % of the samples on both sampling dates (Table 3.2-2). Pebble alone (>31.5 mm) was the second most predominant substrate component forming 29 and 28 % of the July and August pipe sampler samples respectively. The per cent of coarse sand (0.5-2.0 mm) was slightly greater in the July pipe sampler samples ($\bar{x}$=15%) than in the August pipe sampler samples ($\bar{x}$=14%). The medium sand component (.250-.500 mm) was greater in the August pipe samples ($\bar{x}$=4.9%) than in the July pipe samples ($\bar{x}$=3.9%). The mean pipe sampler fine sand component (0.125-0.250mm) was 0.1% higher in the August samples ($\bar{x}$=0.4%) than in the July samples (0.3%). All mean values for substrate components less than 0.1025 mm were <0.1% on both sampling dates. No significant differences could be determined between the July and August particle size components ($P > .05$).

3.3 Fish Monitoring

The day and night fish catch results are presented in Appendix C. A general description of the shoreline substrate and aquatic vegetation present at each sampling site is provided in Appendix D.

A total of 10 fish species were collected during the daylight fish collections (Appendix C). Yellow perch were the dominant fish species collected (n=62 fish/20 min of shocking). Daylight sampling results indicated the highest densities of fish were collected at sites H (n=54 fish/20 min of shocking) and I (n=37 fish/20 min of shocking). No fish were collected at sites C and D. Young of the year yellow perch (n=50 fish/20 min of shocking) were predominant at site H while Cyprinids (n=35 fish/20 min of shocking) were predominant at site I.

Fifteen fish species were collected at the sampling sites during the August night sampling period (Appendix C). Yellow perch was

Table 3.2-1

Ponar Grab and Pipe Sampler
Mean Particle Size Samples
Mississagi River, July 1983

Particle Size (mm)	Ponar Grab	Pipe Sampler	Significance (P>.05)
>31.5	33.7*	28.9	NS
2.00-31.5	57.4	52.3	NS
1.00-2.00	1.0	3.6	NS
0.500-1.00	5.7	11.0	S
0.250-0.500	2.0	3.9	S
0.125-0.250	0.1	0.3	S
0.063-0.125	<0.1	<0.1	NS
0.038-0.063	<0.1	<0.1	NS

* - per cent of substrate (dry weight)

NS - not significant

S - significant

Table 3.2-2

PIPE SAMPLER MEAN
PARTICLE SIZE SAMPLES
MISSISSAGI RIVER, 1983

Particle Size (mm)	July	August	Significance (P>.05)
>31.5	28.9	28.4	NS
2.00-31.5	52.3	52.2	NS
1.00-2.00	3.6	3.4	NS
0.500-1.00	11.0	10.6	NS
0.250-0.500	3.9	4.9	NS
0.125-0.250	0.3	0.4	NS
0.063-0.125	<0.1	<0.1	NS
0.038-0.063	<0.1	<0.1	NS

* - PER CENT OF SUBSTRATE (DRY WEIGHT)

NS - NOT SIGNIFICANT

the dominant species collected and the only species collected at all sampling stations (Table 3.3-1). Pink salmon, Cyprinidae, log perch and walleye were the other dominant fish species collected. Walleye and log perch were located at 6 and 5 sampling sites respectively. All other species were located at < 5 of the 10 sampling sites.

TABLE 3.3-1

Dominant Fish Species
Night Sampling
Mississagi River Project, 1983

SPECIES	MEAN NUMBER OF FISH PER 100 M OF SHORELINE
Yellow Perch	21.2
Pink Salmon	3.6
Cyprinidae*	2.8
Log Perch	1.7
Walleye	1.3

* Cyprinidae - bluntnose minnow, mimic shiner, emerald shiner

Fish were most abundant at construction site F(n=118 fish/100 m of shoreline, Table 3.3-2). The majority of these fish were young of the year yellow perch. The mean fish abundance at site A was 49.3 fish/100 m of shoreline. However, the majority of these fish were prespawn pink salmon. The mean fish abundance at site A without the inclusion of Salmonid species was only 12.3 fish/100 m of shoreline. Fish abundance at sites E and C were 38 and 32 fish/100 m of shoreline respectively. The lowest numbers of fish were recorded at sites D and G.

The mean fish abundance at the treated quarried stone sites (E and F) was greater than at the control sites A and B excluding Salmonids) with similar cobble-boulder shoreline (Table 3.3-3, Appendix D). Young of the year fish comprised the greatest numbers of fish at the construction sites while adults formed the majority of fish captured at the control sites excluding Salmonids). The mean fish abundance at sites G and H (cleared of debris) with sand and aquatic vegetation was less than the mean fish abundances at the upstream (C&D) and downstream (I&J) control sites. Slightly more young of the year fish were collected at the control sites than adult fish. More young of the year fish than adult fish were collected at the construction sites.

TABLE 3.3-2

Sampling Site Fish Abundance
(Number of Fish/100 m of Shoreline)
Mississagi River Project, 1983

Site	Total Number	Number Without Salmonids	Adults	Young of Year	Description
A	49.3	12.3	5.7	6.6	Red Rock Tailrace, cobble
B	12	12	11	1	Shino Rapids, cobble
C	32	32	9	23	control, sand and debris
D	9	9	6	3	control, sand and debris
E	38	38	5	33	quarried stone, east bank
F	118	118	11	107	quarried stone, west bank
G	9	9	5	4	debris cleared, sand
H	10	10	2	8	debris cleared, sand and vegetation
I	23	23	22	1	control, sand and debris
J	24	24	4	20	control, sand and vegetation

TABLE 3.3-3

Fish Abundance At Shoreline Types
(Number of fish/100 m of shoreline)
Mississagi River Study, 1983

Quarried Stone and Cobble-Boulder

	Control	Treated
Total Number	30.7	78.0
Without Salmonids	12.1	78.0
Adults	8.3	8.0
Young of Year	3.8	70.0
Yellow Perch		
Total Number	3.3	70.5
Adults	1.7	0.5
Young of year	1.7	70.0

Sand and Aquatic Vegetation

	Control	Treated
Total Number	22.0	9.5
Adults	10.3	3.5
Young of Year	11.8	6.0
Yellow Perch		
Total Number	13.3	5.5
Adults	2.0	0
Young of year	11.3	5.5

Analysis of the distribution of the dominant fish species, yellow perch, indicated they were more abundant at the treated quarried stone sites than at the comparable cobble-boulder control sites (Table 3.3-3). The yellow perch at the quarried stone construction sites were primarily young of the year fish. Equal numbers of adult and young of the year fish were present at the control sites. Only young of the year yellow perch were captured at the sand and aquatic vegetation construction sites where debris had been removed while more young of the year yellow perch than adults were collected at the control sites with similar habitat.

4.0 DISCUSSION AND SUMMARY

4.1 Water Quality

The water quality results indicated no long term or extensive effect on the Mississagi River water quality during the bank stabilization work at site F and between sites H and I and J as values measured prior to and after construction were similar. All increases in monitored water quality parameters were within OMOE limits. Increases in some water quality parameters (turbidity) were very localized and centered around the construction at site F. The dilution effect of the river system rapidly returned water quality values to normal or near normal river conditions within 300 m of the construction sites.

4.2 Spawning Habitat

The construction at site F did not appear to effect the spawning habitat near the Highway 17 bridge. The fine sand component was slightly higher during the August sampling period than during July. This may be due to the deposition of suspended materials from the construction site. However, the difference is probably within the normal substrate variability at the sampling area. Filtrable residue results did not indicate a large increase in suspended solids on the water quality sampling dates.

4.3 Fish Monitoring

Night fish catches indicated yellow perch was the dominant fish species and the only species collected at all of the Mississagi River sampling sites. Young of the year yellow perch were more common in the fish catches than adults at most sampling locations. This is normal since they usually inhabit shallower water and are found nearer to shore than adults (Scott and Crossman, 1973). Fall run Salmonids (chinook salmon, pink salmon and rainbow trout) were only collected at control site A below the Red Rock GS tailrace. Fish were most abundant at construction site F and were composed primarily of young of the year yellow perch. The fish abundances at the treated quarried stone sites (E,F) were substantially higher than at the control sites (A,B). This difference in fish abundance may be due to the habitat created by the placement of the quarried stone. Fish abundance at sites to be treated (G,H) was less than at the

control sites (C,D,I,J). The lower fish abundance at the treatment sites may be attributable to the bank clearing operations or to normal fish distribution in the sampling areas.

The numbers of fish and fish species collected during daylight sampling were less than during the night sampling periods. Yellow perch was the dominant fish species collected during daylight sampling. However, the greatest abundance of yellow perch (young of the year) was recorded at treated site H. Very few yellow perch were collected at treated site F.

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APPENDIX A

Water Quality Analysis Results
Mississagi River, 1983

SITE	PARAMETER																	
	JULY						AUGUST						OCTOBER					
	NFR(mg/L)		FR (mg/L)		TURB	COND	NFR(mg/L)		FR(mg/L)		TURB	COND	NFR(mg/L)		FR (mg/L)		TURB	COND
	105	550	105	550	NTU	µs/m	105	550	105	550	NTU	µs/m	105	550	105	550	NTU	µs/m
Red Rock Tailrace (normal)	50	24	3.3	<1	0.23	5.6	66	14	<1	<1	0.42	5.9	54	41	2	<1	0.62	6.1
Red Rock Tailrace (peak)	-	-	-	-	-	-	-	-	-	-	-	-	52	33	1	<1	1.2	6.1
Site F 1 (upstream end)	-	-	-	-	-	-	62	30	4	2	30	6.5	-	-	-	-	-	-
Site F 2 (50 m downstream Site F 1)	-	-	-	-	-	-	51	18	<1	<1	3.6	6.0	-	-	-	-	-	-
Site F 3 (100 m downstream Site F 1)	52	18	5.5	1	0.66	5.7	51	16	<1	<1	1.1	6.0	-	-	-	-	-	-
Site F 4 (200 m downstream Site F 1)	-	-	-	-	-	-	60	30	<1	<1	0.71	6.0	-	-	-	-	-	-
Site F 5 (300 m downstream Site F 1)	50	16	2.0	<1	0.27	6.1	48	6	<1	<1	0.51	5.9	-	-	-	-	-	-
Site H	-	-	-	-	-	-	56	18	<1	<1	0.58	6.0	-	-	-	-	-	-
Sites IJ	-	-	-	-	-	-	74	16	<1	<1	0.55	6.3	-	-	-	-	-	-
Mississagi Chutes (normal)	58	12	1.0	<1	0.28	5.7	60	10	<1	<1	0.68	6.2	60	32	2	<1	1.4	6.0
Mississagi Chutes (peak)	-	-	-	-	-	-	-	-	-	-	-	-	52	28	1	<1	1.6	6.1

NFR - non-filtrable residue
FR - filtrable residue
TURB - turbidity
COND - conductivity

APPENDIX B

PARTICLE SIZE ANALYSIS
MISSISSAGI RIVER, 1983

		JUNE								AUGUST			
		PONAR GRAB				PIPE SAMPLER				PIPE SAMPLER			
SIEVE OPENING (mm)	LOCATION	A	B	C	$\bar{x}$	A	B	C	$\bar{x}$	A	B	C	$\bar{x}$
31.5		43.1*	30.9	27.2	33.7	40.0	37.0	9.7	28.9	26.8	31.0	27.3	28.4
2.00		49.6	58.1	64.5	57.4	38.1	47.6	71.2	52.3	57.9	46.2	52.6	52.2
1.00		1.0	1.6	0.4	1.0	4.9	1.8	4.1	3.6	2.4	3.2	4.7	3.4
0.500		3.6	7.1	6.3	5.7	13.1	8.6	11.2	11.0	8.5	13.0	10.2	10.6
0.250		2.6	2.1	1.4	2.0	3.5	4.6	3.5	3.9	4.1	6.0	4.6	4.9
0.125		0.1	0.1	0.1	0.1	0.3	0.3	0.2	0.3	0.3	0.5	0.3	0.4
0.063		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.038		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

* - percent of substrate (dry weight)

APPENDII C

Fish Catch Results
Mississagi River, August 1983

NIGHT

				CONTROL				TREATED			CONTROL		
STATION		A		B	C	D	E	F	G	H	I	J	
DATE	23/24	24/25	25	24/25	24/25	24/25	24/25	24/25	24/25	24/25	24/25	24/25	Total
Pink Salmon	90	2	15										107
Chinook Salmon	3												3
Rainbow Trout	1												1
Redhorse Sucker					1					1			2
Cyprinidae*				3				4		1	20		28
Rock Bass	4	1							1			1	7
Smallmouth Bass													
adult						1	1					3	5
young of year			1		1								2
Yellow Perch													
adult	1	5	1	1	7	1		1					17
young of year		10			21	3	33	107	3	8	1	20	206
Walleye													
adult				1	1	4	1	1					8
young of year	6	1	1	1	1				1				11
Johnny Darter											1		1
Log Perch		3	2	5			2	4	4				20
Mottled Sculpin				1			1	1					3
Northern Pike											1		1
TOTAL	105	22	20	12	32	9	38	118	9	10	23	24	422

DAY

	CONTROL					TREATED			CONTROL		
STATION	A	B	C	D	E	F	G	H	I	J	TOTAL
DATE	23	23	23	23	23	23	23	23	23	23	
Rainbow Trout	1										1
Redhorse Sucker					2						2
Cyprinidae*									35		35
Rock Bass											
adult	4										4
young of year									1		1
Pumpkinseed									1		1
Yellow Perch											
adult	3					4	2	2		1	12
young of year								50			50
Walleye											
adult	2	1									3
young of year	1							1			2
Log Perch	2				5		1	1			9
TOTAL	13	1	0	0	7	4	3	54	37	1	120

*Cyprinidae - bluntnose minnow
emerald shiner
spottail shiner

APPENDIX D

Sampling Location Bottom Types
Mississagi River Project, 1983

SITE		SUBSTRATE	AQUATIC VEGETATION
Red Rock	A	cobble equivalent to quarried stone	none
Shino Rapids	B	cobble and boulders	none
	C	sand with deadheads	scattered
	D	sand with deadheads	scattered
	E	quarried stone 8 in. minus	none
	F	quarried stone 8 in. minus	none
	G	sand with deadheads	scattered
	H	sand	abundant
	I	sand with deadheads	scattered
	J	sand	abundant

* vegetation - submergent Vallisineria, Sparganium sp

POOR

QUALITY

ORIGINAL